Experimental Design

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#1 R Program

```
# 데이터 입력
abrasion = c(17,14,12,13,14,14,12,11,13,13,10,11,13,8,9,9)
brand=as.factor(rep(c("A", "B", "C", "D"),4))
car = as.factor(rep(1:4, each=4))
tire = data.frame(abrasion, brand, car)

# Anova
abrasion.aov=aov(abrasion~car+brand,data=tire)
summary(abrasion.aov)

# glm
abrasion.glm=glm(abrasion~car+brand,data=tire)
summary(abrasion.glm)
```

#1 R ANOVA Output

```
             Df Sum Sq Mean Sq F value  Pr(>F)
car           3  38.69  12.896  10.038 0.00313 **
brand         3  30.69  10.229   7.962 0.00668 **
Residuals     9  11.56   1.285
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> # glm
> abrasion.glm=glm(abrasion~car+brand,data=tire)
> summary(abrasion.glm)
```

#1 R GLM Output

```
Call:
glm(formula = abrasion ~ car + brand, data = tire)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.9375  -0.6875   0.1875   0.6250   1.0625

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  16.1875     0.7497  21.592 4.62e-09 ***
car2         -1.2500     0.8015  -1.560 0.153279
car3         -2.2500     0.8015  -2.807 0.020466 *
car4         -4.2500     0.8015  -5.303 0.000492 ***
brandB       -2.0000     0.8015  -2.495 0.034118 *
brandC       -3.5000     0.8015  -4.367 0.001805 **
brandD       -3.2500     0.8015  -4.055 0.002863 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 1.284722)

    Null deviance: 80.938  on 15  degrees of freedom
Residual deviance: 11.563  on  9  degrees of freedom
AIC: 56.209

Number of Fisher Scoring iterations: 2
```

#1 SAS Program

```
data one ;
do car = "1", "2", "3", "4" ;
do brand = "A", "B", "C", "D" ;
input abrasion @@ ;
output ;
end ;
end;
datalines ;
17 14 12 13
14 14 12 11
13 13 10 11
13 8 9 9
run;

proc glm data = one;
class car brand;
model abrasion = car brand/solution p;
run;
```

#1 SAS Output

SAS 시스템

The GLM Procedure

Dependent Variable: abrasion

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	69.37500000	11.56250000	9.00	0.0022
Error	9	11.56250000	1.28472222		
Corrected Total	15	80.93750000			

R-Square	Coeff Var	Root MSE	abrasion Mean
0.857143	9.396525	1.133456	12.06250

Source	DF	Type I SS	Mean Square	F Value	Pr > F
car	3	38.68750000	12.89583333	10.04	0.0031
brand	3	30.68750000	10.22916667	7.96	0.0067

Source	DF	Type III SS	Mean Square	F Value	Pr > F
car	3	38.68750000	12.89583333	10.04	0.0031
brand	3	30.68750000	10.22916667	7.96	0.0067

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	8.687500000	B	0.74971059	11.59	<.0001
car 1	4.250000000	B	0.80147434	5.30	0.0005
car 2	3.000000000	B	0.80147434	3.74	0.0046
car 3	2.000000000	B	0.80147434	2.50	0.0341
car 4	0.000000000	B	.	.	.
brand A	3.250000000	B	0.80147434	4.06	0.0029
brand B	1.250000000	B	0.80147434	1.56	0.1533
brand C	-0.250000000	B	0.80147434	-0.31	0.7622
brand D	0.000000000	B	.	.	.

#2 R Program

```
stay <-c(20,25,24,28, 25,30,28,31, 22,29,24,26, 27,28,25,29, 21,30,30,32,
         30,30,39,40, 45,29,42,45, 30,31,36,50, 35,30,42,45, 36,30,40,60,
         31,32,41,42, 30,35,45,50, 40,30,40,40, 35,40,40,55, 30,30,35,45,
         20,23,24,29, 21,25,25,30, 20,28,30,28, 20,30,26,27, 19,31,23,30)

TypePatient <- factor(rep(c("Cardiac","Cancer","C.V.A.","Tubercu"), each = 20))
AgeGroup <- factor(rep(rep(1:4, times = 5), times = 4)) # rep(1:4, times = 20)
NurseStay <- data.frame(TypePatient, AgeGroup, stay)

stay.aov = aov(stay ~ TypePatient*AgeGroup, data=NurseStay)
summary(stay.aov)
```

#2 R Output

```
                    Df Sum Sq Mean Sq F value    Pr(>F)
TypePatient          3 2992.5   997.5  67.943  < 2e-16 ***
AgeGroup             3 1201.0   400.3  27.269 1.76e-11 ***
TypePatient:AgeGroup 9  608.5    67.6   4.605 0.000105 ***
Residuals           64  939.6    14.7
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

#2 SAS Program

```
data two ;
do TypePatient = "Cardiac", "Cancer", "C.V.A.", "Tuberculosis" ;
do i = 1 to 5 ;
do AgeGroup = 1 to 4 ;
input stay @@;
output ;
end ;
end;
end;
datalines ;
20 25 24 28    25 30 28 31    22 29 24 26    27 28 25 29    21 30 30 32
30 30 39 40    45 29 42 45    30 31 36 50    35 30 42 45    36 30 40 60
31 32 41 42    30 35 45 50    40 30 40 40    35 40 40 55    30 30 35 45
20 23 24 29    21 25 25 30    20 28 30 28    20 30 26 27    19 31 23 30
run;

proc glm data = two ;
class TypePatient AgeGroup ;
model stay = TypePatient AgeGroup TypePatient * AgeGroup ;
run;
```

#2 SAS Output

SAS 시스템

The GLM Procedure

Dependent Variable: stay

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	4801.950000	320.130000	21.81	<.0001
Error	64	939.600000	14.681250		
Corrected Total	79	5741.550000			

R-Square	Coeff Var	Root MSE	stay Mean
0.836351	11.90866	3.831612	32.17500

Source	DF	Type I SS	Mean Square	F Value	Pr > F
TypePatient	3	2992.450000	997.483333	67.94	<.0001
AgeGroup	3	1201.050000	400.350000	27.27	<.0001
TypePatient*AgeGroup	9	608.450000	67.605556	4.60	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TypePatient	3	2992.450000	997.483333	67.94	<.0001
AgeGroup	3	1201.050000	400.350000	27.27	<.0001
TypePatient*AgeGroup	9	608.450000	67.605556	4.60	0.0001